

Progress Report

ATMOSPHERIC INFRARED SOUNDER

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Microwave “First-Guess” Algorithm

A version of the “microwave first-guess” retrieval algorithm was modified to use SSM/T and SSM/T2 data as substitutes for AMSU-A and AMSU-B. Figure 1 shows brightness temperatures from SSM/T and SSM/T2 over the North Atlantic and part of South America on Jan. 15, 1993. The five least opaque SSM/T channels (out of 7) are shown on the left, and the 5 SSM/T2 channels on the right, all with the same brightness temperature scale. The SSM/T2 measures 16 times as many spots (in a 4 x 4 array) as the SSM/T. Within each group of 5 channels, atmospheric opacity increases from left to right. The 92 GHz channel is not opaque even in the tropics, and high-emissivity land is an obvious feature. Small variations in this channel over the ocean are responses to variations in atmospheric vapor and liquid water. Note that the three channels near 183 GHz indicate an upper-level humidity pattern with substantial differences over the North Atlantic from the lower levels to which the 92 and 150 GHz channels respond.

Figure 2 shows retrieved moisture parameters over the North Atlantic (approximately the upper half of Figure 1). Spots for which the moisture retrieval did not converge are left blank (white). Flat-ocean surface emissivity was assumed (which depends only on temperature and view angle). The moisture variables are retrieved at the SSM/T2 data locations, and temperature (not shown here) at the SSM/T locations. Each temperature retrieval is used in the 16 moisture retrievals associated with it. In this image, white indicates greater moisture, but there are different scales for different variables. The relative humidity (RH) is displayed at 1000, 700 and 400 mb, on a scale running from 0 to 160%. This parameter, when less than 100%, corresponds to the clear part of the IFOV, where the cloud parameterization assumes that the fractional cloud cover at each level is given by

$$b = (RH - 80) / 20,$$

and the cloudy part of the IFOV is assumed to be saturated with water vapor at the retrieved temperature of that level. Because the cloud liquid water parameterization allows partial cloudiness starting at $RH = 80\%$ (over ocean surface), a gray level that is more white than black here implies liquid water at the pressure level. The fourth and fifth swathes are vapor and liquid water integrated through all levels, and the rightmost swath is the rms of the SSM/T2 brightness residuals normalized by channel noise.

In this initial work, no attempt was made to screen out areas of precipitation, which produce non-physical amounts of liquid water due to the very low brightness temperatures caused by scattering. Another non-physical result is the block pattern that results from the influence of the temperature profile on the relative humidity retrieval and on vapor mixing ratio. This effect could be reduced by introducing more horizontal smoothing of the temperature field.

A positive result of this experiment is the ability of the algorithm to reproduce the different moisture patterns at different pressure levels. At 1000 mb, the ridge of water vapor extending from southwest to northeast through the center of the image is consistent with the 92 and 150 GHz channels, while at 400 mb, the retrieval shows a pattern like that in the 183-GHz channels. The humidity distribution at 700 mb shows traces of both patterns. The conclusion is that the algorithm is producing humidity retrievals with true vertical resolution, although we are not yet in a position to quantify the resolution. Similar retrievals at the 15-km horizontal resolution of AMSU-B could be done when that instrument is launched.

Cloud Clearing Algorithms

Neural network estimation techniques have been evaluated. The retrieval problem has been divided into two parts: first, a single-spot retrieval is performed where the temperature profile and "cloud-impact" profile are estimated for each of nine spots. This information is then input to a neural network which estimates the temperature profile for the 50 km spot.

Recent improvements to the neural net cloud-clearing system have lowered the average tropospheric RMS error for the cld2lr-test training set to 0.70 from 0.77. Analysis is underway for the two-cloud formation data. We are also working on increasing accuracy in the lower troposphere (800mb-surface).

A manuscript describing the retrieval algorithm is in preparation.

Figure Captions

1. Brightness temperatures from the SSM/T and SSM/T2.
2. Retrieved relative humidity at three levels, integrated vapor and cloud liquid, and normalized rms brightness residuals.
3. Neural net improvement over linear for a single-spot retrieval.
4. Neural net improvement over averaging for combining nine single-spot retrievals into a final 50-km retrieval.

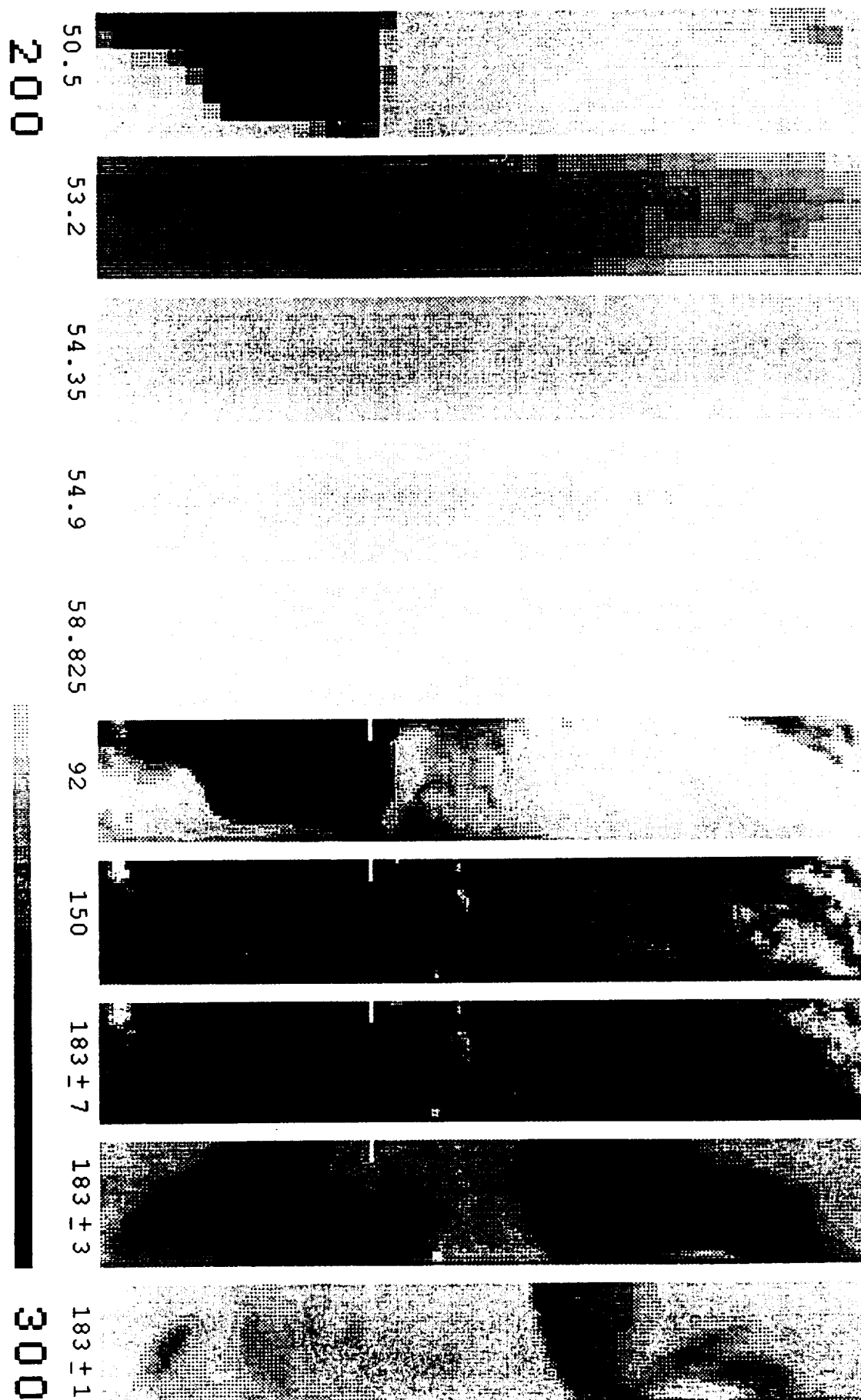


Figure 1

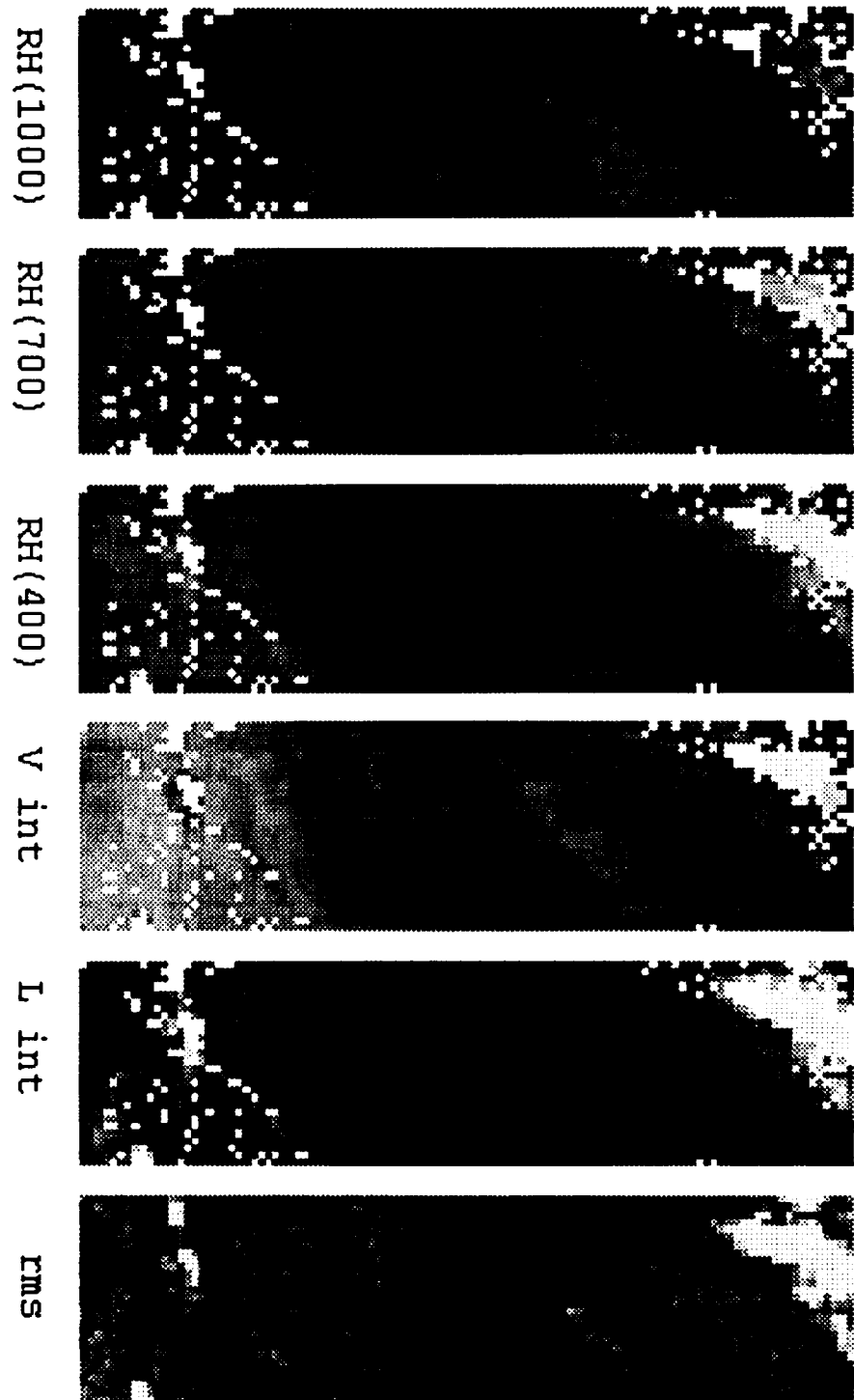


Figure 2

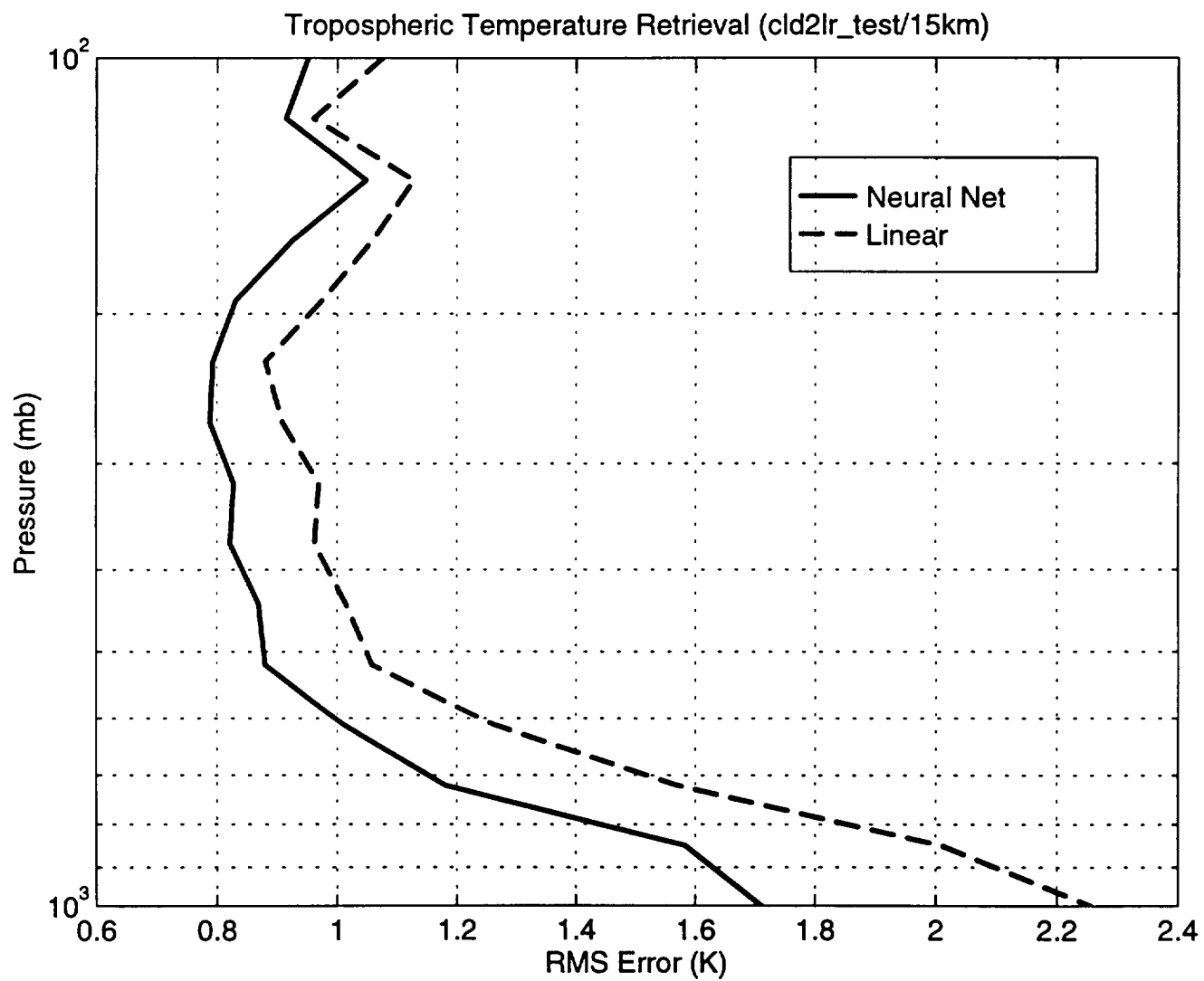


Figure 3

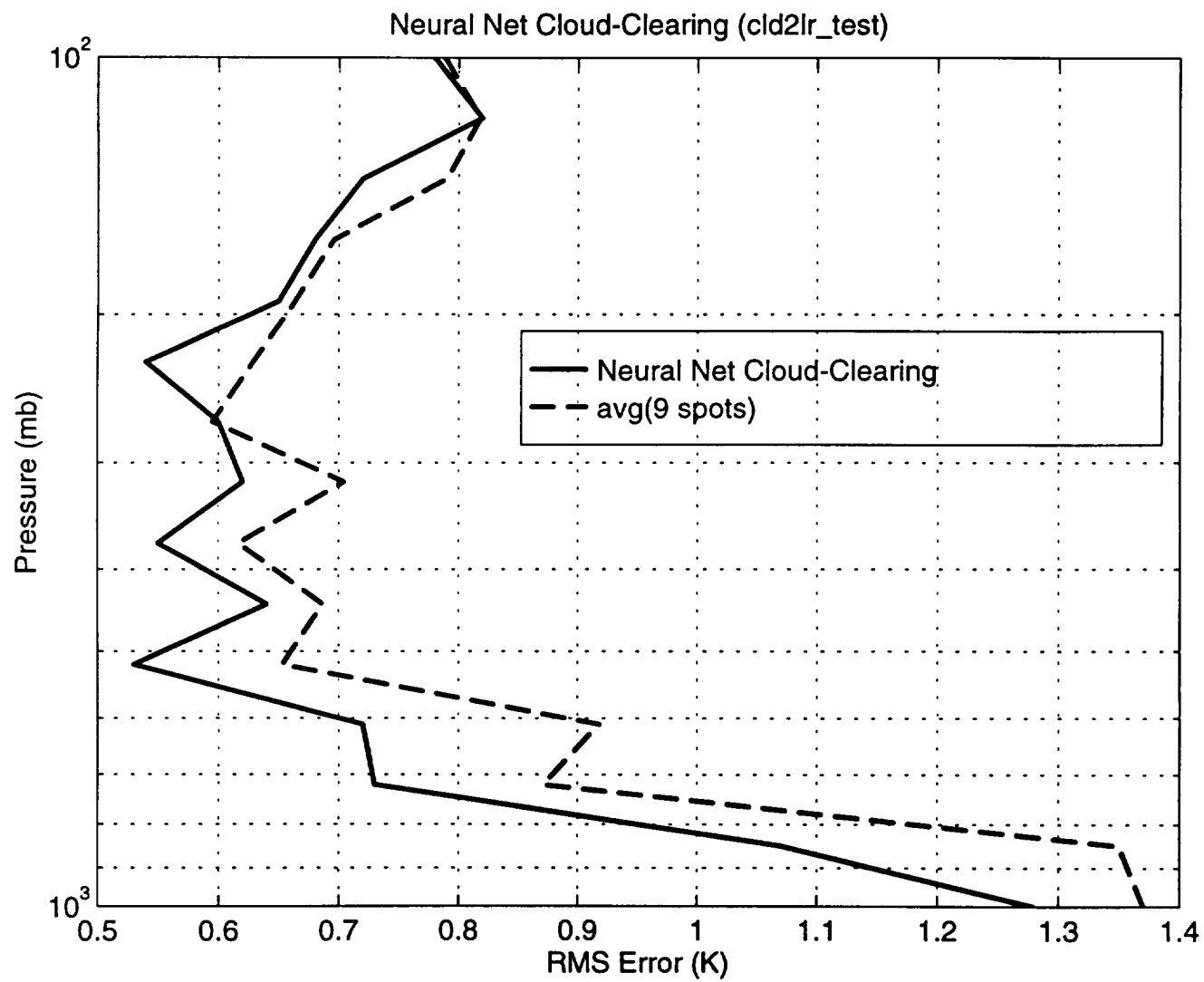


Figure 4



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